Ten scenarios for the future of design education

A critical literature review and reflection to map scenarios on a macro, meso, and micro level.

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There is a shared understanding that design educations' conventional approaches need to be challenged, however, most studies only present research on a micro level, that is, discusses innovations on a single course and neglect a holistic and strategic revision of design education including of the meso and macro levels. Therefore, this study adds to the discussion by presenting a critical literature review that reflects on previously con-ducted systematic reviews and focus groups. The outcome of this procedure are ten scenarios that show possibilities for the future of design education mapped on a mac-ro, meso, and micro framework. It was found that design education in the future could (and should) incorporate collaborations and awareness on a macro level; question con-ventional university structures; and un-tangle and clarify students' knowledge acquisi-tion processes. By presenting these scenarios the authors hope to contribute to the discussion on what the future of design education should entail.

Keywords: Future of design education; design pedagogy; skills for industry 4.0; critical review; micro/meso/macro levels

Introduction

The need for a discussion about the future of design education is indisputable as is shown by the current, on-going important questions raised on multiple platforms. That is not only illustrated by the call for research within this conference track, but also by recent publications that claim design education must transform, and that the critical period for it to do so is now (Vogel & Wang, 2019). There are three interrelated rationales as to why design education finds itself at this crossroad now. First, a number of scholars claim that due to a progressively intricate world a stronger level of wicked-, complex-, and ill-defined problem solving skills are needed (Friedman, 2012; Vogel & Wang, 2019). A wicked problem, hints at an iterative, non-linear model of the design process (Buchanan, 1992). These are ill-formulated, confusing problems that deal with many stakeholders with conflicting values (Buchanan, 1992). Secondly, designers need to be more mindful of their role in society especially regarding equal rights, racism, and privilege issues (Rittner, 2020). Thirdly, designers were found to need an additional skillset in order to deal with the technological acceleration related to industry 4.0, so called skills for industry 4.0, or 21st century skills (Schneorson et al., 2019). These connected rationales are often consolidated into the argument that design education of the future should teach a systems approach to problem solving in multidisciplinary teams (García Ferrari, 2017).

Recent and current conferences on design education are evidence of a coherent effort towards understanding what the future of design education will look like. In most cases it is the department of a university that is responsible for determining what future curricula should include (Valtonen, 2016). Similarly, at our university, we are currently reforming the Bachelor and Master's curricula. In setting out to do so, the authors carried out a systematic review study of the future-proofness of design education (which is currently under review) guided by the discussion on learning objectives, teaching and learning activities, and assessment methods for future

design education. This three-pillar framework (consisting of learning objectives, teaching and learning activities, and assessment) is referred to as the constructive alignment framework and was first introduced by Biggs (1996).

Following these conferences, the field of design education comes to a shared understanding that the current design education system needs to be re-evaluated, and questions arise on what the future for this system then should look like. Although some research indicates recommendations for action, such as, strengthening collaborating skills on co-creation and facilitating, teaching non-product design, stimulating collaborations among professors of different disciplines, and collaborating with industry experts (Augsten & Gekeler, 2017), others hint at future trends, namely, computational design, biology, robotics, and additive manufacturing as new domain specific knowledge to be added into design curricula (Di Lucchio, 2017). However, most studies that present research on what the future of design should look like, only include findings from specific case studies on a micro level. That is, most studies that report on interventions for a future perspective in design education are situated at a course or curriculum level. There is a lack of research that looks at all recommendations in a holistic manner and strategically maps future scenarios on a macro (societal), meso (organizational), and micro level. To address this gap, the paper presents a critical review of literature that points at the need for a reform of design education on a macro, meso and micro level. It will further illustrate ten future scenarios within this framework for design education. By identifying these scenarios, the authors hope to broaden the dialogue on possible extreme and disruptive models of design education, including utopias and dystopias as requested by this conference track.

Structuring the discussion on macro, meso, and micro dimensions

As stated, most discussions on future scenarios for design education are held at a department level since departments are generally responsible to implement curricula changes (Valtonen, 2016). Within our own department we found there to be a need for a framework to structure such discussions, especially since some utopias for the future seem outside of a departmental scope. Reflecting on how universities offering design education programs generally conduct research into design education, the authors found there to be an intuitive need to look at things up close without losing track of the broader context. These intuitive ideas were confirmed by Mitchell and colleagues, who presented concepts for future directions for design education on an individual level (micro) and organizational level (meso) (Mitchell et al., 2019). Kolmos and colleagues refer to a similar approach as they claim that new scenarios for education should go beyond an add-on approach on a single course dimension (micro), but also entail collaborations within the university (meso), and with companies and society (macro) (Kolmos et al., 2016). Therefore the framework that serves as a basis to present the future scenarios in the results section draws on both ideas and uses a macro, meso and micro level to structure the discussion on what the future of design education should look like. Figure 1 summarizes these collective ideas and indicates what is meant by these different dimensions.
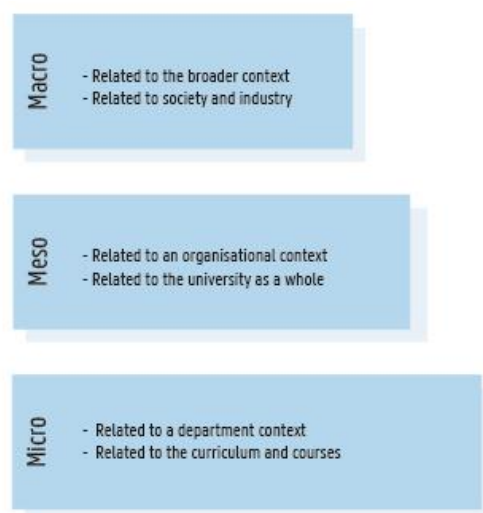

Macro
- Related to the broader context
- Related to society and industry

Meso
- Related to an organisational context
- Related to the university as a whole

Micro
- Related to a department context
- Related to the curriculum and courses

Figure 1. Overview of the macro, meso, and micro level

Scenario development procedure (method)

The research used a mix of methods to collect and reflect on a wide range of data. First a systematic review study was conducted and reported on in a journal paper (this paper is currently under review and will be published by the time the conference is hosted - reference pending). In short this research reviewed 95 articles found through a systemic key-word search in the Web of Science database and seven design, engineering, and education related journals. The results, guided by Bigg's (1996) constructive alignment framework, reported on recent studies in design engineering education. Secondly, the authors reflected on these results and formulated future scenarios for design education mapped on the macro, meso and micro dimensions described above. These were presented to a focus group with select department members at our university. The ten scenarios presented below, were refined from the original scenarios discussed during the focus group and thus incorporate the focus group's comments. Essentially, the results present a critical literature review guided by ten scenarios for the future of design education.

10 scenarios for the future of design education (Results)

Figure 2 presents an overview of the ten scenarios for the future of design education. Three scenarios are situated on the macro level and hint at the broader context in which the field of design education is, could, and should operate. Specifically, the link between design education and industry and society is highlighted in this macro level. Additionally, the call for life-long learning practices is also situated at the macro level since it involves collaborations between design graduates in industry and ongoing learning activities, possibly in collaboration with multiple universities. Scenario four relates to collaborations within the university and is thus positioned at the meso level. Scenarios five and six refer to changes that are quite disruptive to the current education modes. Therefore these need to be addressed on an organizational, university-wide dimension, and consequentially are located at the meso level. Four scenarios are situated on a micro level, that is because these would mostly impact the curriculum directly, or a single course. These scenarios are less complex to implement, as there are less stakeholders to deal with in contrast to scenarios located at the macro, or meso level.
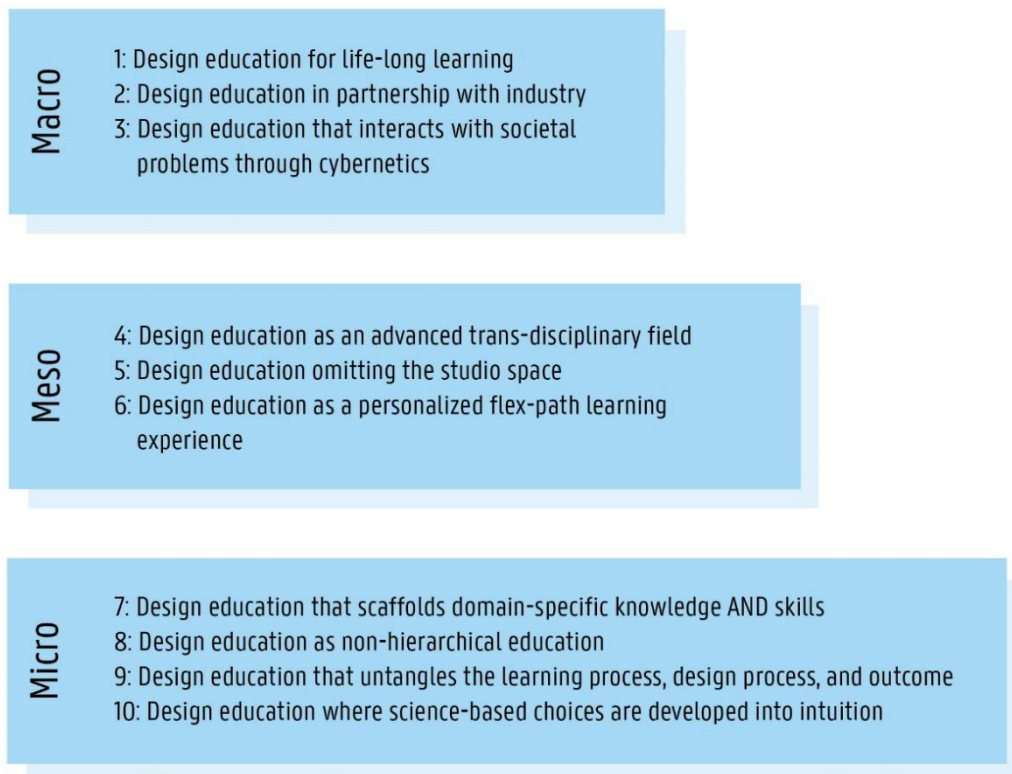
Macro
1: Design education for life-long learning
2: Design education in partnership with industry
3: Design education that interacts with societal problems through cybernetics

Meso
4: Design education as an advanced trans-disciplinary field
5: Design education omitting the studio space
6: Design education as a personalized flex-path learning experience

Micro
7: Design education that scaffolds domain-specific knowledge AND skills
8: Design education as non-hierarchical education
9: Design education that untangles the learning process, design process, and outcome
10: Design education where science-based choices are developed into intuition

Figure 2. Overview of ten future scenarios for design education mapped onto the macro, meso, micro framework

1: Design education for life-long learning

As recent technological changes follow each other in rapid succession, Vogel and Wang (2019) call for a fundamentally different way of educating. Moreover, due to the fact that most graduates' future job descriptions are largely unknown, or of a transdisciplinary nature, it becomes harder to anticipate the domain-specific knowledge and skills students will need in their future jobs (Dziobczenski et al., 2018). Therefore researchers advocate to embed an adjustable definition of the design profession in future design education modes and put broad-minded policies in place for life-long learning (Schneorson et al., 2019). Dziobczenski and colleagues (2018) confirm this by arguing that design education should not only aim to implement future-proof learning objectives but to balance curricula with lifelong learning skills.

When putting lifelong learning into practice, a few researchers state recommendations for the attitudes to focus on and the learning activities best suited for this. Related to attitudes, researchers found that a mindset of knowledge sharing in a curriculum, forms the basis for self-confidence and empowerment for lifelong learning skills (Schneorson et al., 2019). In contrast, competitiveness between students obstructed these skills to develop. Secondly, it is suggested that lifelong learning as an informal way of learning is strongly linked to Massive Open Online Courses (MOOC's) (Haklev, 2016). Connecting this back to the track theme of this conference that asks for modes of design education that are independent of time and space, MOOC's could be a great investment for the field and trigger educational innovation. The authors want to point out that lifelong learning activities can happen within the general design education curriculum (focusing on attitudes of knowledge sharing), but also afterwards as a way to update graduates' knowledge on new developments (possibly with MOOCs). The latter perspective could yield universities a service-based income when implemented intensively with companies.

The idea of lifelong learning and MOOCs is not new. Already in 2012 Schaefer and his fellow researchers claimed that by the year 2020 knowledge workers would dominate and lifelong learning would be the rule (Schaefer et al., 2012). Reflecting on this statement now, we might not be there yet, however, triggered by the changes related to industry 4.0, it is argued that this scenario is most likely to be initiated by students, both current and graduate, who demand universities to keep up with developments and in doing so, share this knowledge (Dziobczenski et al., 2018).

2: Design education in partnership with industry

The need for designers who are alert to new developments, trends, and needs is not only highlighted by the call for lifelong learning skills, but also by the demand for a better alignment of design education and industry. This alignment should be based on a two-fold interaction where design education and industry exchange knowledge and awareness. On the one hand, literature calls to make design students aware of the real conditions of the workplace (Camacho & Alexandre, 2019). This can be achieved by stimulating self-awareness skills as part of professional identity development (Tracey & Hutchinson, 2018), and by increasing the acknowledge the benefits of real briefings that relate to industry contexts (Camacho & Alexandre, 2019). On the other hand, the industry should be made aware of the real importance of research developed by academics (Camacho & Alexandre, 2019). This means that design curricula should consider open projects with industry, establish a close relationship industry in teaching (Camacho & Alexandre, 2019), and co-create these new curricula together with industry (Valtonen, 2016).

3: Design education that interacts with societal problems through cybernetics

In the introduction we already referred to the need for an increase in the designers' awareness of their role in society. Dominici (2017) confirms this by stating that we are living in a more and more complex world, which to a greater extend is interconnected. For this reason designers have to look forward and take the path towards ecological and social responsibility (Dominici, 2017). Moreover, design now needs to consider information flows in order to balance society, a community of systems, and therefore needs a broader point-of-view (García Ferrari, 2017). However, Schneorson and her colleagues report that it is rare to find designers with a wider perspective. To address this, Dominici (2017) concludes to say that design education is obligated to innovate its educational courses in order for designers to be able to deal with more complex, ill-defined, and wicked problems related to society systems.

Questions then arise on what the interpretation of these innovations in design education should entail. How to teach designers problem solving related to systems? Scheorson and her fellow researchers (2019) report on

designers stating that students are too focused on the object, and instead, a broader perspective on a systems thinking approach, holistic, and cybernetics way of thinking is needed (Kaur Majithia, 2017; Schneorson et al., 2019). This call for cybernetics as domain-specific knowledge in design education is confirmed by García Ferrari (2017), who even goes to say that cybernetics, when implemented, is believed to lead to a significant change in the nature of design education.

4: Design education as an advanced trans-disciplinary field

As scenario three illustrates a future for design education in which designers will not only design products but systems as well, scenario four wants to recognize that in order to do so, designers are required to work in trans-disciplinary teams (García Ferrari, 2017). Dubberly questions whether one school or firm can bridge the two and practice both form-giving and system design (Dubberly Hugh, 2008). In the same line, Augsten and Gekeler (2017) rationalise that every design education curriculum should explore systems-thinking in their curricula so that students could become facilitators of collective creativity of others. They claim that designers are evolving from authors of objects to facilitators of change among large groups of people and relate this to the systems approach in scenario three.

So if the designer will become a coordinator of collaboration with specialists, design curricula need to embed these skills into their curricula as well. Academics advocate for a trans-disciplinary approach to achieve this, not only in students' design briefs, but in teaching as well. By creating learning activities centered around co-teaching or team-teaching (Self & Baek, 2017), design students would learn to mix a variation of requirements related to product fabrication, usage, and product context (system) and to facilitate the design process within a trans-disciplinary group (García Ferrari, 2017). Co-teaching is defined as a team that plans, organizes, instructs, and assesses the same group of students (Self and Baek 2017).

5: Design education omitting the studio space

Should design teaching continue to be a be seen as a synonym to studio teaching? Many argue that it should since studio teaching forms the basis of tacit knowledge transfer in design (McDonald & Michela, 2019; Souleles, 2017) and fosters peer learning (Dominici, 2017; Micklethwaite & Knifton, 2017). Through working in a shared studio space, peers learn alongside each other. However, some claim that the studio does not fit into this era of design education as it relies too hard on mimetic learning, which neglects students' individuality (Souleles, 2017). These arguments together with the fact that spaces become increasingly limited in universities led to the questioning of the need for a physical studio space. This questioning is also visible in the call for research within this conference track as it sets out to explore how design education can be time and space independent. Moreover, due to the forced switch to a virtual studio environment due to the ongoing pandemic, this questioning becomes even more relevant.

Should we then omit the studio as a whole? Maybe not, as we can also filter out the ideas of studio teaching that do correspond with current beliefs of what education should look like. Driven by the advances of industry 4.0, several universities recently reformed their curricula and aim to include more active, and peer learning activities (Sackey et al., 2017; Truong et al., 2019). This leads into the idea that instead of a focus on the studio space, design education goes to the core of what studio education aims for, namely peer interaction and learning. Therefore Micklethwaite & Knifton (2017) proposed to rethink the studio space and to create an (online) collaboration space to showcase in-progress work and forge a peer-learning environment.

6: Design education as a personalized flex-path learning experience

As the previous scenarios have explored some time and space independent learning modes for design education, scenario six explores how students' learning experiences could benefit from time and space independent education. Already around the turn of the century researchers explored the idea of permitting students to learn at their own speed (Owen, 1998). This meant that students were allowed to work through a variety of different programs of study and a student-centered approach was implemented. The concept of student-centered learning stays as relevant today considering that academics report on successful curricula reforms focused on a student-centered approach (Mitchell et al., 2019; Truong et al., 2019). Kaur Majithia (2017) extends this discussion by stating that because online and on-demand mobile learning has sky-rocketed, true mobile education on demand will become a reality. The recent, forced global switch towards online or blended learning due to the SARS-CoV-2 pandemic will (probably) only add to this tendency. It is argued that future learners are either senior learners, graduates with industry experience looking to update

their skills and knowledge, or younger learners from an online generation with an ever-shorter attention span (Dziobczenski et al., 2018; Kaur Majithia, 2017). Both profiles will demand flexibility, a good work-life-school balance, convenience, a lower cost learning, and mainly, a personalized flex-path learning experience (Kaur Majithia, 2017).

7: Design education that scaffolds domain-specific knowledge AND skills
Generally design education tends to focus its learning objectives on domain-specific knowledge acquisition, however, the past decade design education's focus has shifted towards students' skill obtaining (Friedman, 2012). Yet, recently, it was found that the considerably stronger focus on skill development should go hand in hand with continued domain-specific knowledge teaching (Friedman, 2012; Kaur Majithia, 2017). To address this need, design education has been implementing more project- and problem-based learning activities, which are defined as activities where students gain domain-specific knowledge and skills by working for an extended period of time on investigating and responding to a complex questions, problems or challenges (Augsten & Gekeler, 2017).

However, as design education commences to aim for students' simultaneous domain-specific knowledge and skill acquisition, it becomes clear that students need support systems to transfer acquired domain-specific knowledge and skills between projects, problems, courses, and contexts (Miceli & Zeeng, 2017; Whelan et al., 2017; Yuan et al., 2018). To address this issue teachers could help students in scaffolding this knowledge by moving the responsibility of the teacher to a coach or mentor role (Miceli & Zeeng, 2017; Whelan et al., 2017).

8: Design education as non-hierarchical education
The previous scenarios already called for shifts towards flex-path learning, co-teaching, peer-learning, and teachers as coaches or mentors. Essentially, all these concepts are closely linked to student-centered design education which puts the students' learning experience at the center instead of the current focus on the teachers' knowledge transmission. Micklethwaite & Knifton (2017) argue that conventional design education is too teacher-focused, it creates teacher-dependent students for decision making who then fail to reflect on the design process themselves. According to them, this is mainly due to an hierarchical educational approach. This is confirmed by others who claim that only the dynamic of a non-hierarchical approach can result in student engagement (Blau & Shamir-Inbal, 2018), that by deconstructing the idea of a rigid, hierarchical, and competitive education, qualitative values can be recovered (Dominici, 2017), and that real innovation and creativity related to design education modes, can only be achieved by stepping away from a classical, hierarchical model (Augsten & Gekeler, 2017). Essentially, this scenario calls for a shift from the all-knowing design teacher to a more approachable teacher who stimulates bottom-up reflection and design actions from a mentor or coaching role.

9: Design education that untangles the learning process, design process, and outcome
When it comes to assessment, design education has a long history of focusing its evaluation both on the outcome (summative assessment) and the process (formative assessment). Proof of this focus is found in the specific assessment tools that are implemented, such as, notebooks for process quality, a self-reporting questionnaire, and assessing reflection (Hong & Choi, 2015). However, as the previous scenarios outlined a shift towards student-centered education, the field of design education comes to an understanding that not only design outcomes and design processes but also the learning process is of great importance. Evidence for this move is already found in team assessment tools that not only focus on design outcomes or design process parameters, but also on learning process parameters, for instance, knowledge construction (Gweon et al., 2017; McMahon & Bhamra, 2017). Although still quite vague, the authors believe that an evaluation that situates the students abilities in a design process, design outcome, and learning process will lead towards true student-centered education.

10: Design education where science-based choices are developed into intuition
The last scenario proposes for design education to develop a stronger science-based curriculum as design education, in the past, has been struggling with the perception that there is no real scientific content (Bertoni, 2019). Currently, some strongly believe that design choices should be based upon objective scientific-based measured parameters instead of designers purely relying on intuition to guide them in the decision making process (Bertoni, 2019; Lloyd, 2019; Santolaya et al., 2018). It is argued to achieve this through research-led project briefings (Thiessen & Kelly, 2017), including experiments of making something and trying it out (Lloyd,

2019), and conducting experiments using matrices with product specifications (Santolaya et al., 2018). However, this approach might not match how others view the design discipline should evolve. Therefore the authors of this paper propose not to neglect designers' intuition and experience but instead to use this shift towards science-based argumentations as a learning tool in building intuition, experience, and the designers' identity.

Discussion and conclusion

The outlined scenarios discuss, mostly intertwined, possible futures for design education. Some of these shifts are already set into motion, whilst others might be unconventional, or more disruptive. However, the pace of innovation will likely not slow down and therefore, how quickly we are able to innovate becomes ever more important (Kaur Majithia, 2017). This research structures the discussion on what the future of design education should look like on three levels: a macro level, discussing collaborations that transcend the university context, a meso level, that calls for change within the university that exceed a sole change within design departments, and a micro level, that discusses the changes design departments should consider.

The scenarios that relate to the macro level show how design education should position itself towards graduate designers in the field, industry, and society as a whole. It is remarkable that these three scenarios all highly value collaboration and awareness. It could be said that the macro scenarios collectively call for design education to strengthen its relationships and exchange knowledge with all stakeholders and civilization as a whole. The authors argue that in order for macro-changes to happen, universities need to direct their attention outwards and exercise their sense for collaboration.

The scenarios discussing the future on a meso level all criticize the basic structure of conventional universities, and are therefore, more disruptive in their nature. However, as recent technological changes call for a fundamentally different way of educating (Vogel & Wang, 2019), conventional approaches might not be sufficient, and trouble causing newer modes of design education might be crucial in order to keep design education updated. Although the discussed scenarios are sometimes fundamentally different from current university structures, and therefore might obstruct true implementation in the direct future, it is important to still have these discussions. Especially as design is a field in which critical questioning is highly valued, particularly when challenging assumptions about the way things are routinely done in design education (Pontis & van der Waarde, 2020). The authors therefore ask designers of design education to question what the field has accepted and routinely does, and to be open to different ways of looking at things.

Proof that this questioning is already happening is visible in the micro-level scenarios. These discuss the need for un-tangling, clarifying, and a sense of fairness in design education, but mostly these all relate to a student-centered approach. This resulted in the raised discussions on scaffolding knowledge and skills in order to assist students in transferring knowledge, on teachers becoming coaches or mentors, on assessment of process, product, and learning, and on designer identity development based on science. The latter two scenarios, combined, could lead towards a drastic improvement of the objective assessment in design education. Reflecting on these micro-scenarios, the authors call for design institutions to consider a student-centered approach that untangles and clarifies students' knowledge acquisition processes when reformulating design education.

Limitations and future work

Although this paper presents an extensive reflection on already conducted research and focus groups, it mostly extends what is already known through a thoroughly critical review and reflection on what the future of design education could look like. This could be considered a limitation as our perception and view on certain issues, futures, and scenarios might be skewed. However, it could also be considered a strength of the research as we, the authors, were able to reflect on, and select in our understanding of the design education field and align it towards the track theme of futures of design education. In doing so, we hope to tell you about our inquiries on the future of designing design education, and establish a platform for discussions on the design ecosystem and the future of designing design education. We hope this would yield a more targeted discussion, and consequentially an agreed alignment within the design education field. Future research can then be conducted towards actually establishing future scenarios for design education.

References

Augsten, A., & Gekeler, M. (2017). From a master of crafts to a facilitator of innovation. How the increasing importance of creative collaboration requires new ways of teaching design. The Design Journal, 20(sup1), S1058–S1071. https://doi.org/10.1080/14606925.2017.1353049

Bertoni, A. (2019). Introducing value driven design in engineering education: teaching the use of value models in preliminary design. International Journal of Technology and Design Education, 0123456789. https://doi.org/10.1007/s10798-019-09511-x

Biggs, J. (1996). Enhancing Teaching through Constructive Alignment Author (s): John Biggs Published by : Springer Stable URL : http://www.jstor.com/stable/3448076. 32(3), 347–364.

Blau, I., & Shamir-Inbal, T. (2018). Digital technologies for promoting "student voice" and co-creating learning experience in an academic course. Instructional Science, 46(2), 315–336. https://doi.org/10.1007/s11251-017-9436-y

Buchanan, R. (1992). Wicked Problems in Design Thinking. Design Issues, 8(2), 5–21.

Camacho, B., & Alexandre, R. (2019). Design Education. University-industry collaboration, a case study. Design Journal, 22(sup1), 1317–1332. https://doi.org/10.1080/14606925.2019.1594958

Di Lucchio, L. (2017). Design for Next Challenges. The Design Journal, 20(sup1), S1–S8. https://doi.org/10.1080/14606925.2017.1352648

Dominici, L. (2017). Theoretical studies and practical tools for a systemic design educational paradigm. Applications of Systems Thinking principles to design education. The Design Journal, 20(sup1), S1448–S1458. https://doi.org/10.1080/14606925.2017.1352669

Dubberly Hugh. (2008). Design in the Age of Biology. Interactions, 15(5), 35-. http://proquest.umi.com/pqdweb?did=1562226221&Fmt=7&clientId=20824&RQT=309&VName=PQD

Dziobczenski, P. R. N., Person, O., & Meriläinen, S. (2018). Designing career paths in graphic design: A document analysis of job advertisements for graphic design positions in finland. Design Journal, 21(3), 349–370. https://doi.org/10.1080/14606925.2018.1444874

Friedman, K. (2012). Models of Design: Envisioning a Future Design Education. Visibile Language, 46.1(2), 132–153.

García Ferrari, T. (2017). Design and the Fourth Industrial Revolution. Dangers and opportunities for a mutating discipline. The Design Journal, 20(sup1), S2625–S2633. https://doi.org/10.1080/14606925.2017.1352774

Gweon, G., Jun, S., Finger, S., & Rosé, C. P. (2017). Towards effective group work assessment: even what you don't see can bias you. International Journal of Technology and Design Education, 27(1), 165–180. https://doi.org/10.1007/s10798-015-9332-1

Haklev, S. (2016). From Seminar to Lecture to MOOC: Scripting and Orchestration at Scale. ProQuest Dissertations and Theses, May, 220. https://doi.org/10.13140/RG.2.2.26281.39528

Hong, Y.-C., & Choi, I. (2015). Assessing reflective thinking in solving design problems: The development of a questionnaire. British Journal of Educational Technology, 46(4), 848–863. https://doi.org/10.1111/bjet.12181

Kaur Majithia, R. (2017). What's Next in Design Education? Transforming role of a designer and its implications in preparing youth for an ambiguous and volatile future. The Design Journal, 20(sup1), S1521–S1529. https://doi.org/10.1080/14606925.2017.1352676

Kolmos, A., Hadgraft, R. G., & Holgaard, J. E. (2016). Response strategies for curriculum change in engineering. International Journal of Technology and Design Education, 26(3), 391–411. https://doi.org/10.1007/s10798-015-9319-y

Lloyd, P. (2019). You make it and you try it out: Seeds of design discipline futures. Design Studies, 65, 167–181. https://doi.org/10.1016/j.destud.2019.10.008

McDonald, J. K., & Michela, E. (2019). The design critique and the moral goods of studio pedagogy. Design Studies, 62, 1–35. https://doi.org/10.1016/j.destud.2019.02.001

McMahon, M., & Bhamra, T. (2017). Mapping the journey: visualising collaborative experiences for sustainable design education. International Journal of Technology and Design Education, 27, 595–609. https://doi.org/10.1007/s10798-016-9365-0

Miceli, L., & Zeeng, L. (2017). Reconstructing the critique. Using inclusive formative feedback in face-to-face and online communities of practice to improve knowledge acquisition in design education. Design Journal, 20(sup1), S1250–S1259. https://doi.org/10.1080/14606925.2017.1352654

Micklethwaite, P., & Knifton, R. (2017). Climate Change. Design Teaching for a New Reality. The Design Journal, 20(sup1), S1636–S1650. https://doi.org/10.1080/14606925.2017.1352687

Mitchell, J. E., Nyamapfene, A., Roach, K., & Tilley, E. (2019). Faculty wide curriculum reform: the integrated engineering programme. European Journal of Engineering Education, 0(0), 1–19. https://doi.org/10.1080/03043797.2019.1593324

Owen, C. (1998). The Challenge of Open Learning in Art & Design Further Education. Journal of Art & Design Education, 17(3), 237–244. https://doi.org/10.1111/1468-5949.00132

Pontis, S., & van der Waarde, K. (2020). Looking for Alternatives: Challenging Assumptions in Design Education. She Ji, 6(2), 228–253. https://doi.org/10.1016/j.sheji.2020.05.005

Rittner, J. (2020). Design Education Reform: Modeling Equity and Inclusion in Teaching and Learning. Design Management Review, 31(3), 12–22. https://doi.org/10.1111/drev.12236

Sackey, S. M., Bester, A., & Adams, D. (2017). Industry 4.0 learning factory didactic design parameters for industrial engineering education in South Africa. 28(1), 114–124.

Santolaya, J. L., Biedermann, A., & Serrano, A. (2018). Using matrices of specifications, factors and concepts to assist design-engineering students. International Journal of Technology and Design Education, 28, 771–786. https://doi.org/10.1007/s10798-017-9403-6

Schaefer, D., Panchal, J. H., Lane Thames, J., Haroon, S., & Mistree, F. (2012). Educating engineers for the near tomorrow. International Journal of Engineering Education, 28(2), 381–396.

Schneorson, D., Persov, E., & Bigger, R. (2019). Designing Your Future - 21st Century Skill-Set for Industrial Designers: The case study of Israel Design Field. The Design Journal, 22(sup1), 243–259. https://doi.org/10.1080/14606925.2019.1595862

Self, J. A., & Baek, J. S. (2017). Interdisciplinarity in design education: understanding the undergraduate student experience. International Journal of Technology and Design Education, 27, 459–480. https://doi.org/10.1007/s10798-016-9355-2

Souleles, N. (2017). Design for social change and design education: Social challenges versus teacher-centred pedagogies. The Design Journal, 20(sup1), S927–S936. https://doi.org/10.1080/14606925.2017.1353037

Thiessen, M., & Kelly, V. (2017). What students say about their work and what it says about their work. Toward the development of rhetorical practice in the educational design studio. Design Journal, 20(sup1), S1511–S1520. https://doi.org/10.1080/14606925.2017.1352675

Tracey, M. W., & Hutchinson, A. (2018). Reflection and professional identity development in design education. International Journal of Technology and Design Education, 28, 263–285. https://doi.org/10.1007/s10798-016-9380-1

Truong, T. V, Ha, B. D., & Le, B. N. (2019). The effects of industry 4.0 on teaching and learning CDIO project at Duy Tan University. Proceedings of the 15th International CDIO Conference.

Valtonen, A. (2016). Designing Universities of the Future. DRS2016: Future-Focused Thinking, 2, 1–16. https://doi.org/10.21606/drs.2016.205

Vogel, C. M., & Wang, X. (Cecilia). (2019). Observations on the State of Design Education: Past, Present, Future. Design Management Review, 30(1), 26–32. https://doi.org/10.1111/drev.12158

Whelan, L., Maher, C., & Deevy, C. (2017). Towards a University Design School. Restoring the value of tacit knowledge through assessment. The Design Journal, 20(sup1), S1459–S1470. https://doi.org/10.1080/14606925.2017.1352670

Yuan, X., Song, D., & He, R. (2018). Re-Examining 'Learning by Doing': Implications from Learning Style Migration. The Design Journal, 1–18. https://doi.org/10.1080/14606925.2018.1444126

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